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(54) **ORGANIC LIGHT EMITTING ELEMENT AND METHOD OF MANUFACTURING THE SAME**

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(52) **U.S. Cl.**
CPC ***H01L 27/3227*** (2013.01); ***H01L 27/3269*** (2013.01)

(58) **Field of Classification Search**
CPC H01L 27/3227; H01L 27/3269
See application file for complete search history.

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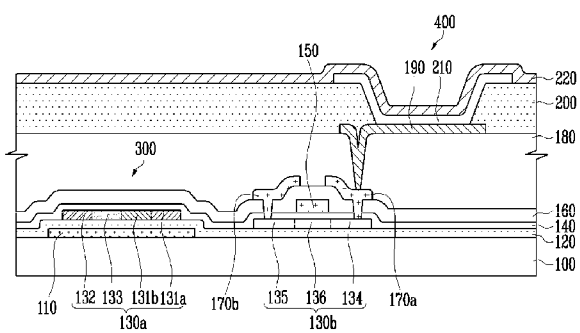
(57) **ABSTRACT**

An organic light emitting element includes an organic light emitting diode formed on a substrate, coupled to a transistor including a gate, a source and a drain and including a first electrode, an organic thin film layer and a second electrode; a photo diode formed on the substrate and having a semiconductor layer including a high-concentration P doping region, a low-concentration P doping region, an intrinsic region and a high-concentration N doping region; and a controller that controls luminance of light emitted from the organic light emitting diode, to a constant level by controlling a voltage applied to the first electrode and the second electrode according to the voltage outputted from the photo diode.

11 Claims, 7 Drawing Sheets



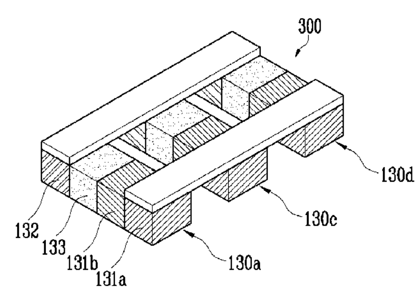


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FIG. 1
(RELATED ART)

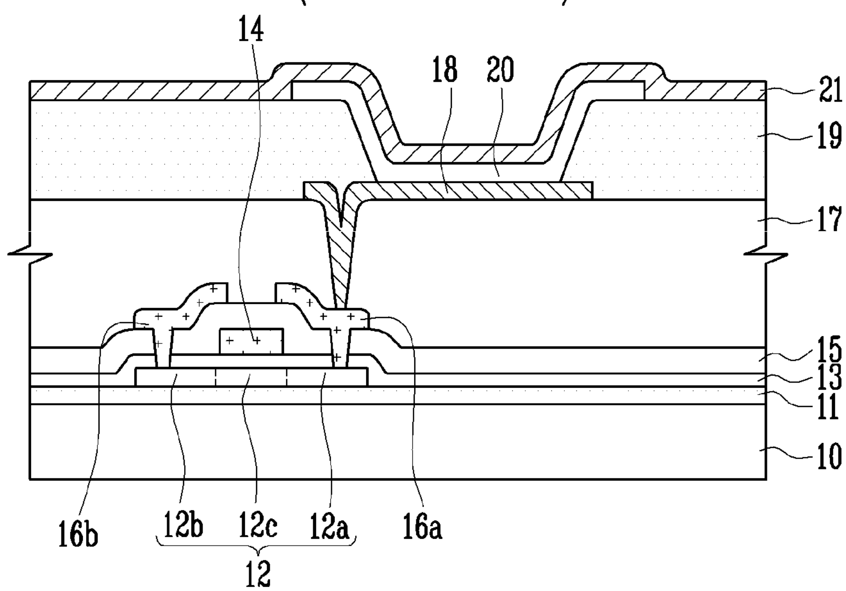


FIG. 2

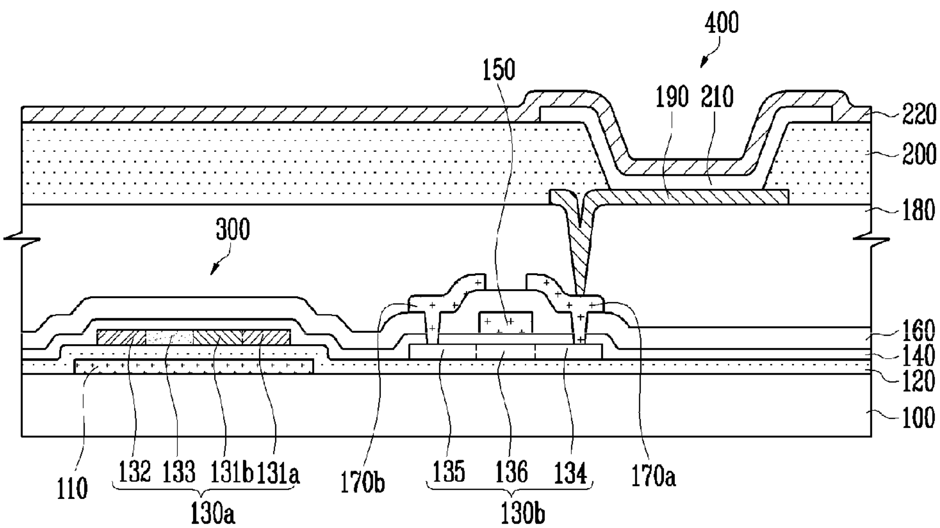

400
150
190
210
220
200
180
300
160
140
120
100
110
132
133
131b
131a
130a
170b
135
136
134
130b
170a

FIG. 3A

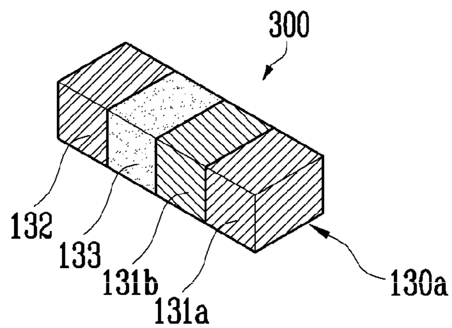

300
132
133
131b
131a
130a

FIG. 3B

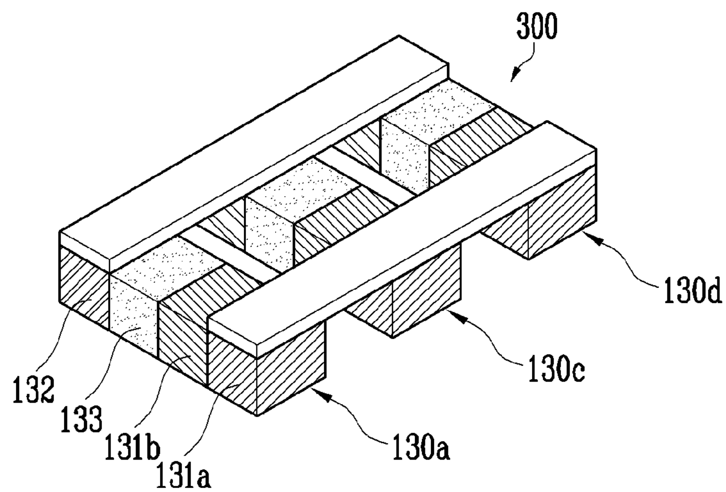

300
130d
130c
132
133
131b
131a
130a

FIG. 4A

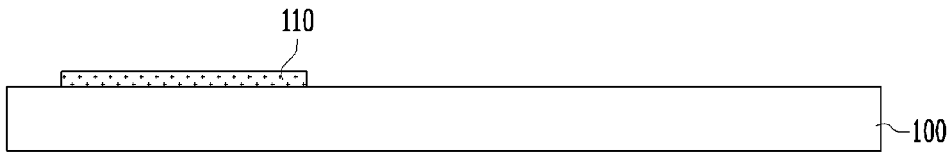


FIG. 4B

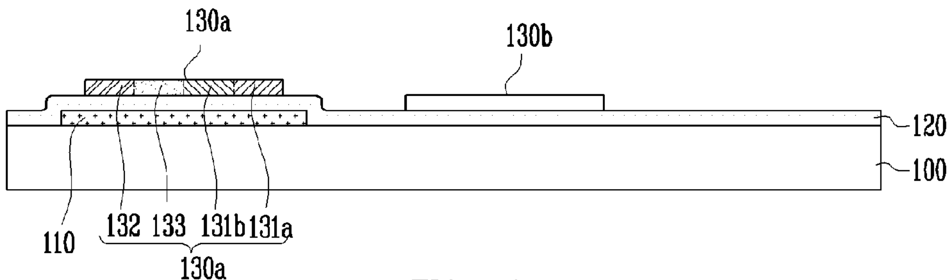


FIG. 4C

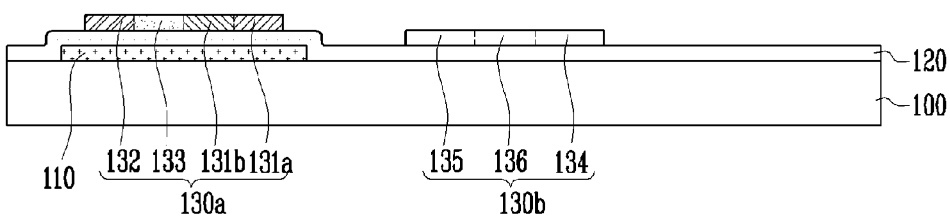


FIG. 4D

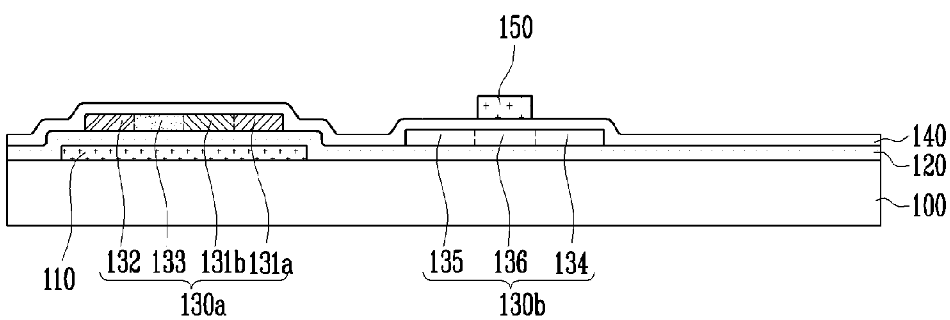


FIG. 4E

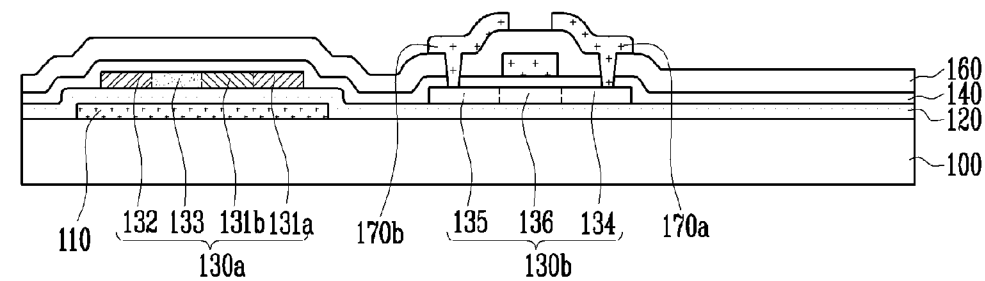

160
140
120
100
110
132
133
131b
131a
130a
170b
135
136
134
130b
170a

FIG. 4F

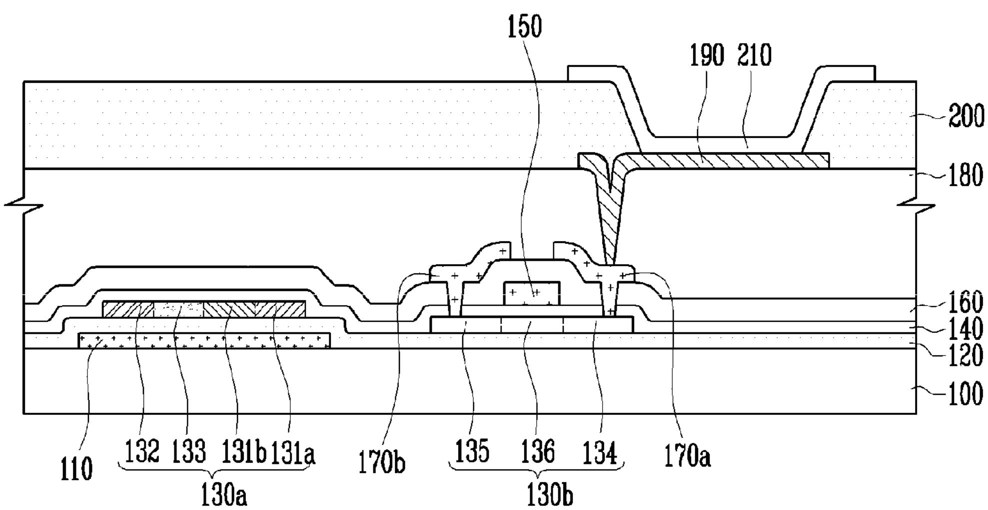

150
190
210
200
180
160
140
120
100
110
132
133
131b
131a
130a
170b
135
136
134
130b
170a

FIG. 4G

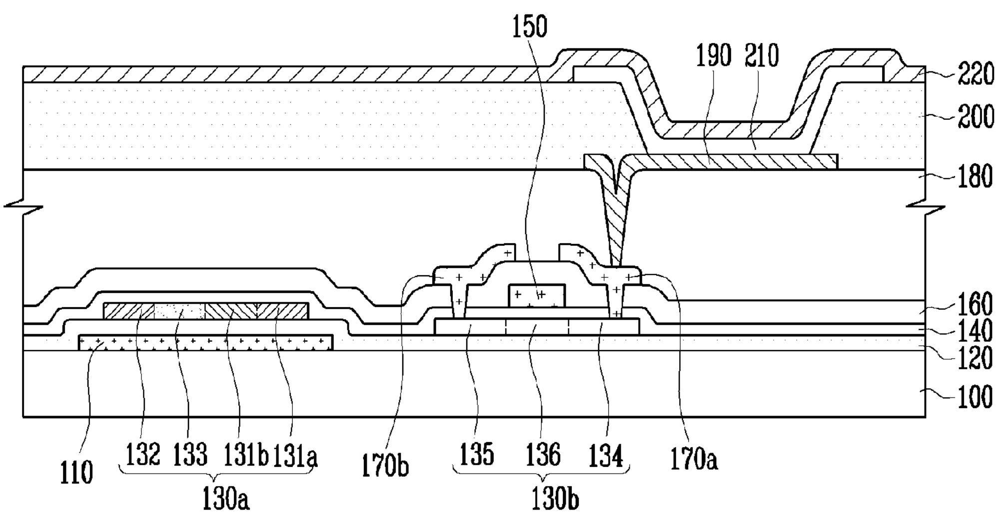
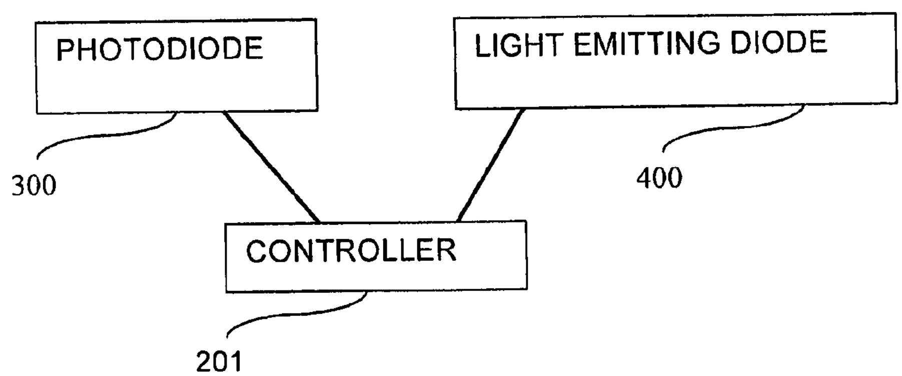

150
190 210
220
200
180
160
140
120
100
110
132 133 131b 131a
130a
170b
135 136 134
130b
170a

FIG. 5



ORGANIC LIGHT EMITTING ELEMENT AND METHOD OF MANUFACTURING THE SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a divisional of U.S. patent application Ser. No. 12/098,641, filed on Apr. 7, 2008, and claims the benefit of Korean Application No. 10-2007-0066880, filed Jul. 4, 2007, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field

Aspects of the present invention relate to an organic light emitting element and a method of manufacturing the same. More particularly, aspects of the present invention relate to an organic light emitting element having a photo diode in which a low-concentration P doping region is formed, and a method of manufacturing the same.

2. Description of the Related Art

Organic light emitting elements are the next-generation display devices having self-light emission properties. Organic light emitting elements have excellent physical properties in terms of viewing angle, contrast, response time, power consumption and the like, compared to the liquid crystal display devices (LCDs).

The organic light emitting element includes organic light emitting diodes comprising an anode electrode, an organic thin film layer and a cathode electrode. Types of organic light emitting elements include a passive matrix mode in which an organic light emitting diode is coupled between scan lines and signal lines in a matrix mode to constitute pixels and an active matrix mode in which operation of respective pixels is controlled by a thin film transistor (TFT) that functions as a switch.

However, the conventional organic light emitting elements have problems that, because an organic thin film layer that emits the light is composed of organic materials, the film quality and light emission properties deteriorate with time, which leads to a reduction in luminance of the light. Also, the contrast of the organic light emitting device may be worsened by the reflection of light incident from the outside.

SUMMARY

Accordingly, aspects of the present invention provide an organic light emitting element having a photo diode to control luminance of the light that is emitted according to the quantity of the light incident from the outside, and a method of manufacturing the same.

Also, aspects of the present invention provide an organic light emitting element capable of enhancing a light detection efficiency of a photo diode, and a method of manufacturing the same.

Also, aspects of the present invention provide an enhanced current efficiency of a photo diode by providing a low-concentration P doping region formed in the photo diode.

In addition, aspects of the present invention provide photo diodes coupled in parallel to each other to enhance a light detection efficiency.

According to an embodiment of the present invention, there is provided an organic light emitting element that includes an organic light emitting diode formed on a substrate, coupled to a transistor including a gate, a source and a drain, and including a first electrode, an organic thin film layer and a second electrode; a photo diode formed on the substrate and having a semiconductor layer joined into a high-concentration P doping region, a low-concentration P doping region, an intrinsic region and a high-concentration N doping region; and a controller to control luminance of the light, emitted from the organic light emitting diode, to a constant level by controlling a voltage applied to the first electrode and the second electrode according to the voltage outputted from the photo diode.

According to an embodiment of the present invention, there is provided a method of manufacturing an organic light emitting element, the method comprising: forming first and second semiconductor layers on a substrate or on a buffer layer formed on the substrate; forming a photo diode by forming a high-concentration P doping region, a low-concentration P doping region, an intrinsic region and a high concentration N doping region in the first semiconductor layer; forming a transistor by forming source and drain region and a channel region in the second semiconductor layer and forming a gate electrode insulated from the channel region; and forming an organic light emitting diode electrically connected to the transistor

According to an embodiment of the present invention, there is provided a method of manufacturing an organic light emitting element that includes forming a buffer layer on a substrate; forming first and second semiconductor layers on the buffer layer; forming a photo diode in the first semiconductor layer, the photo diode having a high-concentration P doping region, a low-concentration P doping region, an intrinsic region and a high concentration N doping region and forming a source and drain region and a channel region in the second semiconductor layer; forming a gate insulator in the entire surface including the first and second semiconductor layers, and then forming a gate electrode on the gate insulator formed on the channel region; forming an interlayer insulator in the entire surface including the gate electrode, and then patterning the interlayer insulator and the gate insulator to form a contact hole so as to exposed the source and drain region; forming source and drain electrodes to be coupled to the source and drain regions through the contact hole; forming an overcoat in the entire surface, forming a via hole on the overcoat to expose a predetermined region of the source or drain electrodes, and then forming a first electrode to be coupled to the source or drain electrodes through the via hole; forming a pixel definition layer to expose some region of the first electrode, and then forming an organic thin film layer on the exposed first electrode; and forming a cathode electrode on the pixel definition layer including the organic thin film layer.

The present invention is not limited to the aspects and embodiments described above, and therefore other aspects and embodiments, unless otherwise specified herein, are understood from the following descriptions, as apparent to those skilled in the art.

Additional aspects and/or advantages of the invention will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

These and/or other aspects and advantages of the invention will become apparent and more readily appreciated from the following description of embodiments, taken in conjunction with the accompanying drawings of which:

FIG. **1** is a schematic cross-sectional view showing a conventional organic light emitting element including a thin film transistor;

FIG. **2** is a cross-sectional view showing an organic light emitting element having a photo diode according to aspects of the present invention;

FIG. **3**A is a schematic view showing a semiconductor layer of the photo diode according to one embodiment of the present invention;

FIG. **3**B is a schematic view showing photo diodes having a parallel configuration according to another embodiment of the present invention; and

FIG. **4**A to FIG. **4**G are cross-sectional views showing a method of manufacturing an organic light emitting element according to the present invention; and

FIG. **5** is a schematic view of the photodiode, light emitting diode and controller according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

Reference will now be made in detail to the present embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to the like elements throughout. The embodiments are described below in order to explain the present invention by referring to the figures.

Herein, it is to be understood that where is stated herein that one layer is "formed on" or "disposed on" a second layer, the first layer may be formed or disposed directly on the second layer or there may be an intervening layer between the first layer and the second layer. Further, as used herein, the term "formed on" is used with the same meaning as "located on" or "disposed on" and is not meant to be limiting regarding any particular fabrication process.

A light emission layer of the conventional organic light emitting element has problems in that the luminance of the light produced by the light emission layer is reduced with time as the film quality and light emission properties of the organic materials making up the light emission layer deteriorate with time. In order to solve the above and/or other problems, the present inventors have found a method to control luminance of the emitted light at a constant level by detecting light incident from the outside, or the light emitted from the inside, using a photo diode. However, the light detection area and efficiency of the display device may decrease as the size of the photo diode becomes smaller with the decreasing size and thickness of the display device.

According to aspects of the present invention, light detection efficiency is enhanced by reflecting the light that transmits through a photo diode and the light that is directed toward a substrate when light is incident from the outside and allowing incidence of the light on the photo diode.

FIG. **1** is a schematic cross-sectional view showing a general organic light emitting element including a thin film transistor. A buffer layer **11** is formed on a substrate **10**, and a semiconductor layer **12** provided with source and drain regions **12***a*, **12***b* and a channel region **12***c* is formed on the buffer layer **11**. A gate electrode **14** that is insulated from the semiconductor layer **12** by a gate insulator **13** is formed on the semiconductor layer **12**, and an interlayer insulator **15** is formed on the entire upper surface including the gate electrode **14**. The interlayer insulator **15** has a contact hole formed therein to exposed the source and drain regions **12***a*, **12***b*. Source and drain electrodes **16***a*, **16***b* are formed on the interlayer insulator **15**, the source and drain electrodes **16***a*, **16***b* being coupled to the source and drain regions **12***a*, **12***b* through the contact hole, and an overcoat **17** is formed over the entire upper surface including the source and drain electrodes **16***a*, **16***b*. The overcoat **17** has a via hole formed therein to expose the source or drain electrodes **16***a* or **16***b*. On the overcoat **17** is formed an anode electrode **18** coupled to the source or drain electrodes **16***a* or **16***b* through the via hole and a pixel definition layer **19** that exposes a predetermined region of the anode electrode **18** to define a light emission region. An organic thin film layer **20** and a cathode electrode **21** are formed on the anode electrode **18**.

As described above, the organic light emitting element, which comprises an anode electrode **18**, an organic thin film layer **20** and a cathode electrode **21**, emits light due to an energy gap. Emission of light occurs when a predetermined voltage is applied to the anode electrode **18** and the cathode electrode **21** such that electrons injected through the cathode electrode **21** are recombined with holes injected through the anode electrode **18** in the organic thin film layer **20**.

The organic light emitting element as shown in FIG. **1** has a problem that its film quality and light emission properties may deteriorate with time, since the organic thin film layer **20** is made of organic materials.

FIG. **2** is a cross-sectional view showing an organic light emitting element having a photo diode according to aspects of the present invention. A reflective film **110** is formed in a predetermined region of a substrate **100**. The reflective film **110** is formed in a non-light emission region adjoining a light emission region and is made of at least one metal such as Ag, Mo, Ti, Al, or Ni. A buffer layer **120** is formed on the entire surface of the substrate **100** including the reflective film **110**. A first semiconductor layer **130***a*, which comprises a high-concentration P doping region **131***a*, a low-concentration P doping region **131***b*, a high-concentration N doping region **132** and an intrinsic region **133**, is formed on the buffer layer **120** formed on the reflective film **110**. A second semiconductor layer **130***b* having source and drain regions **134**, **135** and a channel region **136** are formed on the buffer layer **120** adjoining the first semiconductor layer **130***a*. A gate electrode **150**, which is insulated from the second semiconductor layer **130***b* by the gate insulator **140**, is formed on the second semiconductor layer **130***b*, and an interlayer insulator **160** having a contact hole formed therein to expose the source and drain regions **134**, **135** is formed on the entire upper surface including the gate electrode **150**. Source and drain electrodes **170***a*, **170***b*, which are coupled to the source and drain regions **134**, **135** through the contact hole, are formed on the interlayer insulator **160**, and an overcoat **180**, which has a via hole formed therein to expose the source or drain electrode **170***a* or **170***b*, is formed on the entire upper surface including the source and drain electrodes **170***a*, **170***b*. On the overcoat **180** is formed a first electrode **190** (typically, the anode) coupled to the source or drain electrode **170***a* or **170***b* through the via hole. A pixel definition layer **200** that exposes a predetermined region of the first electrode **190** to define a light emission region, and an organic thin film layer **210** and a second electrode **220** (typically, the cathode) are formed on the first electrode **190**. The organic thin film layer **210** is formed with a structure in which a hole transfer layer, an organic light emission layer and an electron transfer layer are laminated, and may further include a hole injection layer and an electron injection layer.

As described above, in the case where the first electrode **190** is the anode and the second electrode **220** is the cathode, electrons injected through the second electrode **220** are recombined with holes injected through the first electrode **190** in the organic thin film layer **210** if a predetermined voltage is applied to the first electrode **190** and the second electrode **220**, and then the organic light emitting diode **400** emits the light due to the presence of the energy gap generated in this process. It is to be understood that the organic light emitting diode **400** is not limited to this configuration and that the position of the anode and the cathode may be reversed. If light is incident on the organic light emitting element from an external light source while the produced light is emitted as described above, the photo diode **300**, which is formed of the first semiconductor layer **130***a* including the high-concentration P doping region **131***a*, the low-concentration P doping region **131***b*, the high-concentration N doping region **132** and the intrinsic region **133**, detects the light incident from the outside to generate an electrical signal according to the quantity of the light.

The photo diode **300** is a semiconductor element that converts an optical signal into an electrical signal. Therefore, if light is incident on the photo diode under a reverse-bias state, that is to say, a state in which a negative (−) voltage is applied to the high-concentration P doping region **131***a* and a positive (+) voltage is applied to the high-concentration N doping region **132**, then an electrical current flows in the photo diode as the electrons and the holes move along a depletion region formed in the intrinsic region **133**. As a result, the photo diode **300** outputs a voltage that is proportional to the quantity of the light. As shown in FIG. **5**, a controller **201** receives a voltage outputted from the photo diode **300** and controls a voltage applied to the light emitting diode **400**. In the operation of the light emitting diode, the controller **201** receives a voltage outputted from the photo diode **300** and controls a voltage applied to the light emitting diode **400**. Accordingly, the luminance of the light emitted according to the quantity of light incident from the outside may be controlled by controlling a voltage that is applied to the first electrode **190** and the second electrode **220** of the organic light emitting diode **400** according to the voltage outputted from the photo diode **300**.

The first semiconductor layer **130***a* will be described in more detail, as shown below in FIG. **3**A. As described above, according to aspects of the present invention, light that is incident from the outside and that transmits through a photo diode **300** or is directed toward the substrate **100** is reflected by the reflective film **110** and then, the reflected light is incident on the photo diode **300**, which leads to the improvement of light detection efficiency.

In general, the first semiconductor layer **130***a* that forms the photo diode **300** is formed of polysilicon, and therefore, it is difficult to ensure a sufficient light detection efficiency since the first semiconductor layer **130***a* is typically formed at a very thin thickness of about 500 Å. Also, the light detection efficiency of display devices including a photo diode **300** may be additionally worsened as photo diodes are made smaller to accommodate a decreasing size and thickness of display devices. However, it is possible to reduce the size of the photo diode **300** since the light detection efficiency is enhanced through the presence of the reflective film **110**.

Conventionally, the semiconductor layer of a photo diode is formed of a high-concentration P doping region, an intrinsic region and a high-concentration N doping region. In the case of the conventional photo diode having this general PIN structure, electrons-hole pairs are mainly generated in the intrinsic region, which is the central region of the semiconductor layer. The holes have a relatively slower mobility than the electrons and have a relatively shorter life time than the electrons since the holes have a high possibility to recombine with other electrons more quickly. An electric current flows toward the holes. According to aspects of the present invention, if a low-concentration P doping region is arranged between the intrinsic region and the high-concentration P doping region such that a point where electrons-hole pairs are generated is moved toward the low-concentration P doping region, more holes can move to an electrode while the holes are not recombined, in comparison to the case of a photo diode having a symmetrical PIN structure. Therefore, it is possible to provide more current flow under the same incident light conditions since the average life time of the holes may be extended.

If the photo diode were to be formed together with the intrinsic region to absorb the incident light by simply widening the high-concentration P doping region, then the life time of the holes would be shortened since the holes would collide with dopants while the holes passed through the high-concentration P doping region. In order to solve the above problem, a low-concentration P doping region is formed according to aspects of the present invention instead of widening the high-concentration P doping region.

FIG. **3**A is a schematic view showing a first semiconductor layer **130***a* of a photo diode **300** according to one embodiment of the present invention. As shown in FIG. **3**A, the photo diode **300** according to one embodiment of the present invention is formed of a first semiconductor layer **130***a* that includes a high-concentration P doping region **131***a*, a low-concentration P doping region **131***b*, a high-concentration N doping region **132** and an intrinsic region **133**.

A high-concentration P doping region **131***a* and a low-concentration P doping region **131***b* are formed in one side of the intrinsic region **133**, and a high-concentration N doping region **132** is formed in the other side of the intrinsic region **133**. Therefore, the photo diode **300** has an asymmetrical configuration with respect to the center of the intrinsic region **133**. The life time of the holes is extended since electrons-hole pairs are mainly generated in the low-concentration P doping region **131***b*. Therefore it is possible to provide greater current flow under the same incident light conditions, compared to the conventional photo diode having a symmetrical PIN structure.

FIG. **3**B is a schematic view showing a photo diode **300** having a parallel configuration according to another embodiment of the present invention. As shown in FIG. **3**B, the photo diode **300** is formed by coupling several first semiconductor layers **130***c*, **130***d* in parallel to the first semiconductor layer **130***a* having the high-concentration P doping region **131***a*, the low-concentration P doping region **131***b*, the high-concentration N doping region **132** and the intrinsic region **133**. The first semiconductor layers **130***c* and **130***d* have the same configuration as the first semiconductor layer **130***a*.

As described above, it is possible to enhance the light detection efficiency of the photo diode **300** by forming the first semiconductor layers **130***a*, **130***c*, **130***d* in parallel.

Hereinafter, the method of manufacturing an organic light emitting element according to one embodiment of the present invention will be described in detail with reference to FIG. **4**A to FIG. **4**F.

Referring to FIG. **4**A, a reflective film **110** is formed in a predetermined region by depositing one or more metals, such as Ag, Mo, Ti, Al, Ni and the like, onto a substrate **100** using a sputtering process, etc., followed by patterning the substrate **100** by an exposure and development process using a predetermined mask. The metal that forms the reflective film **110** is deposited at a suitable thickness, such as, for example a thickness of 100 to 5,000 Å, to reflect light that reaches the reflective film **110**.

Referring to FIG. **4**B, a buffer layer **120** and a semiconductor layer are sequentially formed on the entire surface of the substrate **100** including the reflective film **110**, and then the semiconductor layer is patterned to provide the first semiconductor layer **130***a* on the reflective film **110** and the second semiconductor layer **130***b* on a region of the buffer layer **120** adjacent to the reflective film **110**. The buffer layer **120** serves to prevent damage to the substrate **100** by the heat and may be made of an insulator such as, for example, a silicon oxide film (SiO_2), or a silicon nitride film (SiN_x). The semiconductor layer is formed of amorphous silicon or polysilicon. For example, if amorphous silicon is used, the amorphous silicon is crystallized through a heat treatment. A high-concentration P doping region **131***a*, a low-concentration P doping region **131***b*, a high-concentration N doping region **132** and an intrinsic region **133** are formed in the first semiconductor layer **130***a* using an N-type and P-type impurity ion injection process to provide a photo diode **300**.

Referring to FIG. **4**C, source and drain regions **134**, **135** and a channel region **136** arranged between the source and drain regions **134**, **135** are formed in the second semiconductor layer **130***b* to provide a transistor.

Referring to FIG. **4**D, a gate insulator **140** is formed on the entire surface of the structure formed in **4**C, including on the first and second semiconductor layers **130***a*, **130***b*, and a gate electrode **150** is then formed on a portion of the gate insulator **140** formed on the channel region **136**.

Referring to FIG. **4**E, an interlayer insulator **160** is formed on the entire surface of the structure formed in **4**D, including on the gate electrode **150**. The interlayer insulator **160** and the gate insulator **140** are then patterned to form a contact hole so as to expose the source and drain region **134**, **135** of the second semiconductor layer **130***b*. Source and drain electrodes **170***a*, **170***b* are formed to be coupled to the source and drain region **134**, **135** through the contact hole.

Referring to FIG. **4**F, an overcoat **180** is formed on the entire surface of the structure formed in **4**E to provide a flat surface, and a via hole is then formed in the overcoat **180** to expose a predetermined region of the source or drain electrode **170***a* or **170***b*. An anode electrode **190** is formed to be coupled to the source or drain electrode **170***a*, **170***b* through the via hole. A pixel definition layer **200** is formed on the overcoat **180** to expose a region of the anode electrode **190**, and an organic thin film layer **210** is then formed on the exposed region of the anode electrode **190**. The organic thin film layer **210** may comprise a hole transfer layer, an organic light emission layer and an electron transfer layer, which are laminated, and may further include a hole injection layer and an electron injection layer.

Referring to FIG. **4**G, a cathode electrode **220** is formed on the pixel definition layer **200** including the organic thin film layer **210** to obtain an organic light emitting diode **400** comprising the anode electrode **190**, the organic thin film layer **210** and the cathode electrode **220**.

In the exemplary embodiments, the reflective film **110** may be formed with a wider area than the first semiconductor layer **130***a* in order to effectively reflect light that is directed toward the substrate **100**. Also, although the case that a photo diode is configured so that it can detect the light incident from the outside is described in the embodiment, the present invention is not limited thereto. For example, the photo diode **300** may be configured so that it can detect the light emitted from inside the organic light emitting element and control a voltage applied to the anode electrode **190** and the cathode electrode **220** of the organic light emitting diode. Also, the organic light emitting element may be configured to be operated with a touch panel using the photo diode **300**.

Although a few embodiments of the present invention have been shown and described, it would be appreciated by those skilled in the art that changes might be made in this embodiment without departing from the principles and spirit of the invention, the scope of which is defined in the claims and their equivalents.

What is claimed is:

1. A method of manufacturing an organic light emitting element, the method comprising:

forming a first semiconductor layer in a first area and a second semiconductor layer in a second area on a substrate or on a buffer layer formed on the substrate;

forming an asymmetric photo diode by forming a high-concentration P doping region at a first side of the first area, a low-concentration P doping region making a junction with the high-concentration P doping region, an intrinsic region making a junction with the low-concentration P doping region, and a high concentration N doping region making a junction with the intrinsic region and at a second side of the first area in the first semiconductor layer;

forming a transistor by forming a source region in the second semiconductor layer at a first side of the second area, a drain region in the second semiconductor layer at a second side of the second area, and a channel region between the source region and the drain region in the second semiconductor layer, and forming a gate electrode over and insulated from the channel region; and

forming an organic light emitting diode electrically connected to the transistor.

2. The method of claim **1**, further comprising forming a reflective film on the substrate, wherein the reflective film is positioned to reflect light incident from outside the organic light emitting element to the asymmetric photo diode.

3. The method of claim **2**, wherein the reflective film comprises at least one metal selected from the group consisting of Ag, Mo, Ti, Al and Ni.

4. The method of claim **2**, wherein the reflective film is formed to have a thickness of 100 Å to 5,000 Å.

5. The method of claim **1**, wherein the low-concentration P doping region of the asymmetric photo diode is disposed between the high-concentration P doping region and the intrinsic region, and the high-concentration N doping region is disposed on an opposite side of the intrinsic region from the low-concentration P doping region.

6. A method of manufacturing an organic light emitting element, the method comprising:

forming first semiconductor layers in a first area and a second semiconductor layer in a second area on a substrate or on a buffer layer disposed on the substrate;

forming an asymmetric photo diode by forming a high-concentration P doping region at a first side of the first area in each of the first semiconductor layers, a low-concentration P doping region making a junction with the high-concentration P doping region in each of the first semiconductor layers, an intrinsic region making a junction with the low-concentration P doping region in each of the first semiconductor layers, and a high concentration N doping region making a junction with the intrinsic region and at a second side of the first area in each of the first semiconductor layers, and coupling the first semiconductor layers in parallel at the first side and the second side of the first area;

forming a transistor by forming a source region in the second semiconductor layer at a first side of the second area, a drain region in the second semiconductor layer at a second side of the first area, and a channel region between the source region and the drain region in the second semiconductor layer, and forming a gate electrode over and insulated from the channel region; and forming an organic light emitting diode electrically connected to the transistor.

7. A method of manufacturing an organic light emitting element, the method comprising:

forming a buffer layer on a substrate;

forming at least one first semiconductor layer in a first area and a second semiconductor layer in a second area on the buffer layer;

forming an asymmetric photo diode in each of the at least one first semiconductor layer, the photo diode having a high-concentration P doping region at a first side of the first area, a low-concentration P doping region making a junction with the high-concentration P doping region, an intrinsic region making a junction with the low-concentration P doping region, and a high concentration N doping region making a junction with the intrinsic region and at a second side of the first area, and forming a source region in the second semiconductor layer at a first side of the second area, a drain region in the second semiconductor layer at a second side of the second area, and a channel region between the source region and the drain region in the second semiconductor layer;

forming a gate insulator on the substrate and covering the at least one first semiconductor layer and the second semiconductor layer, and then forming a gate electrode on the gate insulator and over the channel region;

forming an interlayer insulator on the substrate and covering the gate electrode, and then patterning the interlayer insulator and the gate insulator to form a first contact hole exposing the source region and a second contact hole exposing the drain region;

forming a source electrode coupled to the source region through the first contact hole and a drain electrode coupled to the drain region through the second contact hole;

forming an overcoat on the substrate, forming a via hole in the overcoat and exposing the source or drain electrode, and then forming a first electrode coupled to the source electrode or the drain electrode through the via hole;

forming a pixel definition layer on the substrate and exposing the first electrode, and then forming an organic thin film layer on the exposed first electrode; and forming a cathode electrode on the pixel definition layer and the organic thin film layer.

8. The method of claim 7, further comprising forming a reflective film on the substrate, wherein the reflective film is configured to reflect light incident from outside the organic light emitting element to the asymmetric photo diode.

9. The method of claim 8, wherein the reflective film comprises at least one metal selected from the group consisting of Ag, Mo, Ti, Al and Ni.

10. The method of claim 8, wherein the reflective film is formed to have a thickness of 100 Å to 5,000 Å.

11. The method of claim 7, wherein the forming of the asymmetric photo diode comprises:

forming the at least one first semiconductor layer in plurality; and coupling each first semiconductor layer in parallel at the first side and the second side of the first area.

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